QL
696
.S83
A6
1997

A STUDY OF SPOTTED OWL DEMOGRAPHICS IN THE SIERRA NATIONAL FOREST AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

RMRS

ANNUAL PROGRESS REPORT
1997

A STUDY OF SPOTTED OWL DEMOGRAPHICS IN THE SIERRA NATIONAL FOREST AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

by

George N. Steger, Thomas E. Munton, Gary P. Eberlein
and Kenneth D. Johnson

Pacific Southwest Research Station
Fresno, California

December 1997

U.S. Forest Service
Pacific Southwest Library and Information Center
1323 Club Drive
Vallejo, CA 94592-1110

QL
696
.S83
A6
1997

INTRODUCTION

This report summarizes key activities and preliminary results of demographic studies of California spotted owls (*Strix occidentalis occidentalis*) in the Sierra National Forest and the Sequoia and Kings Canyon National Parks for 1997. Demographic studies were initiated in March of 1990. Information collected will allow comparisons between spotted owl demographics in a managed National Forest and protected forests of the National Park. In 1994 an additional study area was initiated in Sierra National Forest to provide complete coverage of the Kings River Ecological Management area. Results from all study areas are provided in this report. All tables and figures have been updated to reflect the current analysis of data for all years (1990-1997). This report supersedes all previous annual reports. Data contained herein are preliminary and permission to publish any of the contents of the report is therefore withheld pending specific authorization.

OBJECTIVES

1. Estimate densities of spotted owls and occupancy status of owl territories in the designated study areas.
2. Estimate vital rates (reproduction, mortality) by age class.
3. Assess site fidelity among individual spotted owls.
4. Estimate the number of missing and replaced spotted owls.
5. Quantify the distribution of habitats within the study areas.
6. Characterize diets of spotted owls from regurgitated pellets, and compare diets of breeding and nonbreeding pairs during the breeding period (1 March to 30 September).

STUDY AREAS

Boundaries of study areas were delineated on major topographic features such as ridges, drainages (major rivers), and administrative boundaries (e.g., Sequoia and Kings Canyon National Parks boundaries). The Sierra National Forest study area (SNF) covers 161 mi^2, the New Sierra study area (NS) covers 103 mi^2 and the Sequoia and Kings Canyon National Parks study area (SNP) covers 130 mi^2 (Fig. 1). Three vegetation zones are found in all study areas, oak woodland (1,000 to 4,000 feet), mid-elevation coniferous forest (4,000 to 8,000 feet) and high elevation coniferous forest (8,000 to 9,600 feet). A detailed description of these vegetation types and the area they occupy for the SNF and SNP can be found in the 1990 annual report (Verner et al. 1990), and NS can be found in the 1993-1994 annual report (Steger et al. 1995).

METHODS

We attempted to locate, capture and color band all spotted owls within the three study areas. Spotted owls were located by night and day calling surveys using vocal imitations of spotted owls to elicit responses (Forsman 1983). Survey methods included point surveys, leap-frog road surveys, and walking cruises. All study areas were subdivided into sites that could usually be completely surveyed during a workday.

The protocols for surveying, determining social, nesting and reproductive status can be found in Verner et al. (1990). In general, we attempted to apply equal survey effort over years and study areas. Survey effort may have been influenced by inclement weather conditions,

such as high winds or steady rain, and water noise when surveying drainages.

Adult and subadult survival rate, as well as juvenile survival rate, and fecundity, were used to estimate the population growth rate (lambda [λ]). Adult and subadult survival rate (S) included both males and females and included owls that may temporarily occupy a territory. Jolly-Seber (J-S) survival estimates were calculated with the J-S capture-recapture model for open populations, allowing for losses and gains to the population between sampling periods. A sampling period was defined as one field season (1 March-30 September). Assumptions of the J-S model were that all individuals in the population have equal survival and capture probabilities and emigration was permanent. The juvenile survival rate (S_o) was estimated at 0.328, the current estimate for a closed population of spotted owls in southern California (LaHaye et al. 1997). Fecundity (b) equaled the number of female fledglings produced divided by the number of females checked for reproduction. Assuming a 50/50 sex ratio of juveniles, fecundity was calculated by halving the mean number of young fledged per pair. The estimate of λ allowed testing of the hypothesis that a population was significantly increasing ($\lambda>1$) or decreasing ($\lambda<1$). The appropriate test statistics followed a *Z*-distribution.

RESULTS

SURVEY

Surveys began in all study areas in the first week of March and ended on 30 September. Several changes in survey effort occurred in 1997 because of budget constraints. In mixed conifer sites a priority system of calling was initiated to ensure that full coverage (six surveys) was obtained in sites where owls were detected in previous years. Low-elevation sites received three surveys unless an owl was detected. When owls were detected the site was surveyed until full protocol was achieved. Sites above 8,000 ft (2,438 m) that had no history of owl detections were not surveyed in 1997.

DETECTION AND CAPTURE

On the SNF, 57 adult and subadult owls were detected (a decline of 11 from 1996) (Table 1a). Twenty-five pairs were found in 1997 and eight juveniles were produced. Pair numbers and reproduction were similar to the 1995 and 1996 seasons. For the eight years of the study, the SNF has averaged 29.4 pairs/year, producing an average of 17 juveniles/year, or 0.578 juveniles per pair per year. In 1997, twelve owls (4 adults, 6 subadults, and 2 of unknown age; 6 males, 5 females, and 1 unknown sex) were captured. The 1997 adult-subadult ratio changed to 89:11 from the 80:20 recorded in 1996 (Table 2a). All 8 juveniles that were found in the study area in 1997 were captured and banded, 5 juveniles were fitted with radio transmitters for a study of survival rate and dispersal distances.

For SNP, the number of owls detected declined to 63 in 1997 from the 66 found in 1996. Twenty-nine pairs were detected in 1997 and 11 juveniles were fledged (Table 1b). The average number of juveniles fledging per year is 13.8 from an average of 28 pairs of owls, or 0.49 juveniles per pair per year. All owls aged on the SNP in 1997 were adults; three new owls were captured and banded (1 male and 2 females). All juveniles found were captured and banded.

On the NS study area, 26 owls were detected: 12 pairs, one single female, and one female present (Table 1c). Four juveniles were fledged in 1997. NS averaged 4.5 juveniles from 13.5 pairs of owls, or 0.33 juveniles per pair per year for the 4 years of study. The adult/subadult ratio was 96:4, the same as 1996 (Table 2c). All juveniles detected were captured and banded; three of these were fitted with radio transmitters.

DENSITY

Densities in owls per square mile for 1997 were 0.36 on SNF, 0.49 on SNP, and 0.25 on NS (Table 3). The mean densities of owls for the eight years of study were 0.456 on SNF and 0.505 on SNP. The four year average for the NS study area was 0.30

MISSING OWLS, REPLACMENTS AND MOVEMENTS

Numbers of banded owls missing on the SNF varied substantially from 1990 through 1997 (Tables 4a-4g). In 1996-1997 there were 54 banded owls with confirmed status: 41 owls were present, 13 owls were confirmed missing, 10 were replaced and three moved to a new site within the study area. The empirical relocation rate, or the number of banded owls relocated from the previous year was 82% for 1991, 85% for 1992, 86% for 1993, 78% for 1994, 79% for 1995, 77% for 1996 and 76% for 1997. The average relocation rate for the time period of 1990-1997 was 81%.

Missing, replacement, and movement data for the NS are reported in tables 5a-5c. In 1996-1997 there were 26 banded owls of which 21 were relocated, five were missing, and two replacements were found.

Numbers of banded owls missing on the SNP varied substantially from 1990 through 1997 (Tables 6a-6g). In 1996-1997 there were 56 banded owls with confirmed status: 49 owls were present, seven were missing, seven were replaced, and two moved within the study area. The empirical relocation rate was 82% for 1991, 83% for 1992, 94% for 1993, 84% for 1994, 85% for 1995, 77% for 1996 and 88% for 1997. The average relocation rate for the time period of 1990-1997 was 85%.

REPRODUCTION AND NESTING ATTEMPTS

Nineteen ninety-seven was another poor year for spotted owl reproduction in the southern Sierra Nevada. In SNF we checked 25 pairs and found 9 nesting, 6 of which fledged 8 young (Tables 7, 8). The mean number of young fledged per pair checked for reproduction was 0.32 (Tables 9, 10). In the SNP we found 6 of 26 pairs nesting and 6 of 27 pairs reproductive, fledging 11 young. The mean number of young fledged per pair checked for reproduction was 0.41. On the NS we found 2 of 10 pairs nesting, both fledged 2 young for a mean number of young fledged per pair checked for reproduction of 0.40.

A total of 275 fledglings have been recorded over the 8 years of the study, 138 in SNF, 119 in SNP, and 18 in NS. We banded 244 (89%) of these young with cohort bands; 35 (14.3%) of these have been recaptured as subadults or adults in the study areas. Sex ratio of returning juveniles was 23/12 (male/female). The sex ratio determined from blood samples of 116 juveniles from 1993 to 1997 was 69/47 (male/female). In the eight years of study, 3 females banded as juveniles have moved between study areas, two from the SNF to SNP and one from SNP to NS. These movements cover approximately 15 to 20 miles.

Reproduction has varied substantially among years but differed little between study areas. In both the SNF and SNP the proportion of pairs fledging young was >40% in 4 years (1990, 1992, 1993, and 1994) and <40% in 4 years (1991, 1995, 1996 and 1997).

POPULATION TREND

Preliminary estimates of demographic parameters and rates of population change (lambda) have been calculated for the SNF, SNF and NS combined, and SNP (table 11). Fecundity (b) declined from 1996 due to poor reproduction on all study areas. For 1990-1997 we found that the fecundity rate for SNF was 0.335, SNF and NS combined was 0.3004, and

SNP was 0.2827. Adult survival rates improved slightly in 1997, causing lambda values to improve slightly over the corresponding 1996 values.

DISCUSSION

In 1997 owl numbers declined on all our study areas and we considered it a poor year in terms of reproduction. The proportion of pairs fledging young (0.22) in the southern Sierra Nevada was below our study average (1990-97 = 0.355), and below those reported for the central Sierra Nevada (1987-1996 = 0.60) (Seamans et al. 1996) and the San Bernardino Mountains (1987-1996 = 0.42) (LaHaye et al. 1997). The combination of three years (1995-1997) of poor reproduction in the southern Sierra Nevada resulted in a decline in the fecundity rate to 0.29. The low reproductive rate may also have contributed to the decline in owl numbers, as fewer subadults were available to occupy territories. Our 1997 age-class distribution shifted towards an adult dominated population. In the SNP, all owls aged were adults. In the Sierra Forest (SNF and NS combined), we found subadults in the study area, 6 of 10 previously unbanded owls were subadults, but the overall proportion of adults increased to 91%.

Our calculation of the rate of population change (lambda) from 1988-1997 suggests that the owl population has declined approximately 7% for SNF and 5% for SNP. The calculations for 1997 indicated that λ remained approximately the same as the 1996 estimate. Lahaye et al. (1996), indicated that the rate of decline in λ in the San Bernardino Mountains has decreased over the last five years. They suggested that easing of the drought conditions of the 1980's may have improved environmental conditions. We noticed that our estimate of survival rate of subadult and adult owls banded in our study area improved in 1997. In one case we had an adult relocated (identified by color band) after being absent for 6 years. Although the estimate of both juvenile survival rate and fecundity were lower in 1997, the improved subadult and adult survival rate caused λ to remain constant in 1997

The estimate (0.328) used for juvenile survivorship in our lambda calculations was derived from the Big Bear spotted owl study in the San Bernardino Mountains. We feel that this is the best estimate to use at this time, although juvenile survivorship in the southern Sierra Nevada may differ from this value. Our return rate of juveniles to the study area (.143) was considered an underestimate of juvenile survivorship, as it did not account for surviving juveniles that moved out of the study area. Seamans et al. (1996) located dispersing juveniles up to 50 miles from their natal areas in the central Sierra Nevada, and we have had three birds detected 15 to 20 miles from their natal area. In 1997 we initiated a radio telemetry study on juvenile spotted owls in the SNF study area. This portion of the demographic study will continue for 3 years and will provide area-specific survival rates for the calculation of population trends. It will also provide information on distance moved and habitats used during dispersal of juvenile California spotted owls.

LITERATURE CITED

Forsman, Eric D. 1993. Methods and materials for locating and studying spotted owls. Gen. Tech. Rep. PNW-162. Portland, OR: U.S. Department of Agriculture, Forest Service. Pacific Northwest Forest and Range Experiment Station. 8p.

LaHaye, W. S., D. G. Leslie, and R. J. Gutiérres. 1996. Big bear spotted owl study, 1996. Final report to Region 5, U.S.D.A. Forest Service. 14 pp.

Seamans, M. E., M. Z. Peery, and R. J. Gutiérres. 1996. Population ecology of the California spotted owl in the central Sierra Nevada: Annual results 1996. Annual Progress Report (Contract #53-91S8-6-FW12). Region 5, U.S.D.A., Forest Service. 16 pp.

Steger, G. N., T. E. Munton, G. P. Eberlein, and K. D. Johnson. 1995. Annual progress report 1993-1994. A study of spotted owl demographics in the Sierra National Forest and Sequoia and Kings Canyon National Parks. . Internal Report, Pacific Southwest Forest and Range Experiment Station, Fresno, California. 6 pp.

Verner, Jared, G. N. Steger, G. P. Eberlein D. A. Leal, and T. E. Munton. 1991. Part 1: Spotted Owl home-range size and composition in the Sierra National Forest. Part 2: Demography of spotted owls in the Sierra National Forest and Sequoia/Kings Canyon National Parks. Annual Progress Report 1990. Internal Report, Pacific Southwest Forest and Range Experiment Station, Fresno, California. 9 pp.

TABLE 1a. Summary of social status of adult and subadult California spotted owls on the SNF.

SOCIAL STATUS	1990	1991	1992	1993	1994	1995	1996	1997
Pair	31	27	32	33	34	27	26	25
Single male	0	2	1	4	4	3	1	3
Single female	0	0	1	1	0	1	1	0
Male & female present	5	0	1	1	1	2	2	0
Male present	9	10	1	4	8	5	4	3
Female present	4	3	3	2	0	3	5	0
Unknown present				1	2	0	1	1
Total Number of Owls	85	69	72	80	84	70	68	57
Juveniles	22	6	52	23	20	1	4	8
Juveniles detected after July 15		1	1					
Total Juveniles	22	7	53	23	20	1	4	8

TABLE 1b. Summary of social status of adult and subadult California spotted owls on the SNP.

SOCIAL STATUS	1990	1991	1992	1993	1994	1995	1996	1997
Pair	22	23	27	28	34	33	28	29
Single male	0	0	0	0	0	0	0	0
Single female	0	1	0	0	0	1	2	1
Male & female present	2	5	0	2	0	2	0	0
Male present	5	1	5	4	4	6	5	1
Female present	1	0	0	2	2	2	0	3
Unknown present	0	2	1	1	0	1	3	0
Female replaced					1			
Total Number of Owls	54	60	60	67	75	80	66	63
Juveniles	12	1	43	15	22	3	3	11
Juveniles detected after July 15	9							
Total Juveniles	21	1	43	15	22	3	3	11

TABLE 1c. Summary of social status of adult and subadult California spotted owls on the NS.

SOCIAL STATUS	1994	1995	1996	1997
Pair	15	14	13	12
Single male	0	0	0	0
Single female	1	1	1	1
Male & female present	0	0	0	0
Male present	3	1	1	0
Female present	2	1	0	1
Unknown present	1	2	0	0
Total Number of Owls	37	33	28	26
Juveniles	9	1	2	4
Juveniles detected after July 15	2			
Total Juveniles	11	1	2	4

Table 2a. Sex and age class distribution of California spotted owls identified to age class on the SNF.

		1990		1991		1992		1993		1994		1995		1996		1997	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	25	81	24	80	27	87	26	72	22	60	22	79	25	86	25	93
	Subadult	6	19	6	20	4	13	10	28	15	40	6	21	4	14	2	7
	Combined	31		30		31		36		37		28		29		27	
Female	Adult	22	88	28	100.0	30	97	30	91	28	85	26	90	22	73	21	84
	Subadult	3	12	0	0.0	1	3	3	9	5	15	3	10	8	27	4	16
	Combined	25		28		31		33		33		29		30		25	
Both	Adult	47	84	52	90	57	92	56	80	50	71	48	84	47	80	46	89
	Subadult	9	16	6	10	5	8	14	20	20	29	9	16	12	20	6	11
	Combined	56		58		62		70		70		57		59		52	

Table 2b. Sex and age class distribution of California spotted owls identified to age class on the SNP.

		1990		1991		1992		1993		1994		1995		1996		1997	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	16	94	19	91	25	96	27	93	22	65	28	82	27	93	26	100
	Subadult	1	6	2	9	1	4	2	7	12	35	6	18	2	7	0	0.0
	Combined	17		21		26		29		34		34		29		26	
Female	Adult	11	85	18	86	25	96	25	89	28	88	33	97	29	97	31	100
	Subadult	2	15	3	14	1	4	3	11	4	12	2	3	1	3	0	0.0
	Combined	13		21		26		28		32		35		30		31	
Both	Adult	27	90	37	88	51	96	52	91	50	76	61	87	57	93	57	100
	Subadult	3	10	5	12	2	4	5	9	16	24	9	13	4	7	0	0.0
	Combined	30		42		53		57		66		70		61		57	

Table 2c. Sex and age class distribution of California spotted owls identified to age class on the NS.

		1994		1995		1996		1997		1998		1999		2000	
Sex	Age Class	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Male	Adult	11	85	12	86	12	92	12	100						
	Subadult	2	15	2	14	1	8	0	0.0						
	Combined	13		14		13		12							
Female	Adult	9	75	15	94	11	100	12	92						
	Subadult	3	25	1	6	0	0	1	8						
	Combined	12		16		11		13							
Both	Adult	20	80	27	90	23	96	24	96						
	Subadult	5	20	3	10	1	4	1	4						
	Combined	25		30		24		25							

TABLE 3.

CRUDE DENSITY

Mean crude density estimates (owls per mi^2) for California Spotted Owls on the SNF, SNP, and NS . Crude density was calculated by dividing the number of owls detected by the number of square miles in each study area.

SNF (160.4 mi^2)	1990	1991	1992	1993	1994	1995	1996	1997
Owls Detected	85	69	72	80	84	70	68	57
Crude Density mi^2	0.530	0.430	0.449	0.449	0.524	0.436	0.424	0.355

SNP (130.0 mi^2)	1990	1991	1992	1993	1994	1995	1996	1997
Owls Detected	54	60	60	67	75	80	66	63
Crude Density mi^2	0.415	0.462	0.462	0.515	0.577	0.615	0.508	0.485

NS (103.0 mi^2)	1994	1995	1996	1997
Owls Detected	37	33	28	26
Crude Density mi^2	0.359	0.320	0.272	0.252

TABLE 4. Relocation, missing, replacement and movement rates for only banded California spotted owls on the SNF: A (1990 to 1991), B (1991 to 1992), C (1992 to 1993), D (1993 to 1994), E (1994 to 1995), F (1995 to 1996), and G (1996 to 1997).

A.

Sex	Age Class	No Banded 1990	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	15	12	80	3	20	4	27	1	7
	Subadult	5	3	60	2	40	2	40	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	20	15	75	5	25	6	30	1	5
Female	Adult	12	11	92	1	8	1	8	1	8
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	13	12	92	1	8	1	8	1	8
Both	Adult	27	27	23	4	15	5	19	2	7
	Subadult	6	6	4	2	33	2	33	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Combined	33	27	82	6	18	7	21	2	6

B.

Sex	Age Class	No Banded 1991	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	17	15	88	2	12	2	12	1	6
	Subadult	5	4	80	1	20	1	20	2	40
	Unknown	0	-	-	-	-	-	-	-	-
	Total	22	19	86	3	14	3	14	3	14
Female	Adult	19	16	84	3	16	3	16	2	11
	Subadult	0	-	-	-	-	-	-	-	0
	Unknown	0	-	-	-	-	-	-	-	0
	Combined	19	16	84	3	16	3	16	2	11
Both	Adult	36	31	86	5	14	5	14	3	8
	Subadult	5	4	80	1	20	1	20	2	40
	Unknown	0	-	-	-	-	-	-	-	-
	Combined	41	35	85	6	15	6	15	5	12

C.

Sex	Age Class	No Banded 1992	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	26	21	81	5	19	5	19	0	-
	Subadult	4	3	75	1	25	1	25	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	30	24	80	6	20	6	20	0	-
Female	Adult	26	24	92	2	8	2	8	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Total	28	26	93	2	7	2	7	0	-
Both	Adult	52	45	87	7	13	7	13	0	-
	Subadult	5	4	80	1	20	1	20	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Combined	58	50	86	8	14	8	14	0	-

D.

Sex	Age Class	No Banded 1993	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	22	15	68	7	32	6	27	0	-
	Subadult	7	5	71	2	29	1	14	1	4
	Unknown	2	2	100	0	-	0	-	0	-
	Total	31	22	71	9	29	7	23	1	3
Female	Adult	29	24	83	5	17	4	14	1	3
	Subadult	2	2	100	0	-	0	-	0	-
	Unknown	2	2	100	0	-	0	-	0	-
	Combined	33	28	85	5	15	4	12	1	3
Both	Adult	51	39	76	12	24	10	20	1	2
	Subadult	9	7	78	2	22	1	11	1	11
	Unknown	4	4	100	0	-	0	-	0	-
	Combined	64	50	78	14	22	11	17	2	3

E.

Sex	Age Class	No Banded 1994	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	20	17	85	3	15	2	10	1	5
	Subadult	10	7	70	3	30	1	10	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	30	24	80	6	20	3	10	1	3
Female	Adult	27	21	78	6	22	4	15	3	11
	Subadult	4	3	75	1	25	1	25	1	25
	Unknown	1	1	100	0	-	0	-	0	-
	Combined	32	25	78	7	22	5	16	4	13
Both	Adult	47	38	81	9	19	6	13	4	9
	Subadult	14	10	71	4	29	2	14	1	7
	Unknown	1	1	100	0	-	0	-	0	-
	Combined	62	49	79	13	21	8	13	5	8

F.

Sex	Age Class	No Banded 1995	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	21	18	86	3	14	3	14	0	-
	Subadult	3	2	67	1	33	0	-	1	33
	Unknown	3	2	67	1	33	1	33	0	-
	Total	27	22	82	5	19	4	15	1	4
Female	Adult	25	17	68	8	32	8	32	0	-
	Subadult	3	3	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Total	29	21	72	8	28	8	28	-	-
Both	Adult	46	35	76	11	24	11	24	0	-
	Subadult	6	5	83	1	17	0	-	1	17
	Unknown	4	3	75	1	25	1	25	0	-
	Combined	56	43	77	13	23	12	21	1	2

G.

Sex	Age Class	No Banded 1996	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	23	20	87	3	13	3	13	2	9
	Subadult	3	1	33	2	67	1	33	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	26	21	81	5	19	4	15	2	8
Female	Adult	22	16	73	6	27	4	18	1	5
	Subadult	5	3	60	2	40	2	40	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Total	28	20	71	8	29	6	21	1	4
Both	Adult	45	36	80	9	20	7	16	3	7
	Subadult	8	4	50	4	50	3	37	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Combined	54	41	76	13	24	10	19	3	6

TABLE 5. Relocation, missing, replacement and movement rates for only banded California spotted owls on the NS: A (1994 to 1995), B (1995 to 1996) and C (1996 to 1997).

A.

Sex	Age Class	No Banded 1994	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	11	9	82	2	18	1	9	0	-
	Subadult	0	-	-	-	-	-	-	-	-
	Unknown	2	2	100	0	-	0	-	0	-
	Total	13	11	85	2	15	1	8	0	-
Female	Adult	9	9	100	0	-	0	-	0	-
	Subadult	3	3	100	0	-	0	-	0	-
	Unknown	2	2	100	0	-	0	-	0	-
	Total	14	14	100	0	-	0	-	0	-
Both	Adult	20	18	90	2	10	1	5	0	-
	Subadult	3	3	100	0	-	0	-	0	-
	Unknown	4	4	100	0	-	0	-	0	-
	Combined	27	25	93	2	7	1	4	0	-

B.

Sex	Age Class	No Banded 1995	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	12	9	75	3	25	3	25	1	8
	Subadult	2	1	50	1	50	0	-	1	50
	Unknown	0	-	-	-	-	-	-	-	-
	Total	14	10	71	4	29	3	21	2	14
Female	Adult	14	12	86	2	14	1	7	1	7
	Subadult	1	0	0	1	100	0	-	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	15	12	80	3	20	1	7	1	7
Both	Adult	26	21	81	5	19	4	15	2	8
	Subadult	3	1	33	2	67	0	-	1	33
	Unknown	0	-	-	-	-	-	-	-	-
	Combined	29	22	76	7	24	4	14	3	10

C.

Sex	Age Class	No Banded 1996	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	10	7	70	3	30	1	10	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Total	12	9	71	3	29	1	8	0	-
Female	Adult	11	10	90	1	10	1	10	0	-
	Subadult	0	0	-	0	-	0	-	0	-
	Unknown	3	2	66	1	33	0	-	0	-
	Total	14	12	86	2	14	1	7	0	-
Both	Adult	21	17	81	4	19	2	10	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	4	3	75	1	25	0	-	0	-
	Combined	26	21	81	5	19	2	8	0	-

TABLE 6. Relocation, missing, replacement and movement rates for only banded California spotted owls on the SNP: A (1990 to 1991), B (1991 to 1992), C (1992 to 1993), D (1993 to 1994), E (1994 to 1995), F (1995 to 1996), and G (1996 to 1997).

A.

		No Banded	RELOCATED		MISSING		REPLACED		MOVED	
Sex	Age Class	1990	N	%	N	%	N	%	N	%
Male	Adult	9	8	89	1	11	1	11	0	-
	Subadult	1	1	100	0	-	0	-	1	100
	Unknown	1	1	100	0	-	0	-	0	-
	Total	11	10	91	1	9	1	9	1	9
Female	Adult	7	5	71	2	29	1	14	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	3	2	67	1	33	1	33	0	-
	Total	11	8	73	3	27	2	18	0	-
Both	Adult	16	13	81	3	19	2	13	0	-
	Subadult	2	2	100	0	-	0	-	1	50
	Unknown	4	3	75	1	25	1	25	0	-
	Combined	22	18	82	4	18	3	14	1	5

B.

		No Banded	RELOCATED		MISSING		REPLACED		MOVED	
Sex	Age Class	1991	N	%	N	%	N	%	N	%
Male	Adult	11	8	73	3	27	2	18	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	3	3	100	0	-	0	-	0	-
	Total	15	12	80	3	20	2	13	0	-
Female	Adult	11	9	82	2	18	3	27	1	9
	Subadult	2	2	100	0	-	0	-	1	50
	Unknown	1	1	100	0	-	0	-	0	-
	Total	14	12	86	2	14	3	21	2	14
Both	Adult	22	17	77	5	23	5	23	1	5
	Subadult	3	3	100	0	-	0	-	1	33
	Unknown	4	4	100	0	-	0	-	0	-
	Combined	29	24	83	5	17	5	17	2	7

C.

Sex	Age Class	No Banded 1992	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	24	24	100	0	-	0	-	0	-
	Subadult	0	-	-	-	-	-	-	-	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	24	24	100	0	-	0	-	0	-
Female	Adult	23	20	87	3	13	3	13	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Total	25	22	88	3	12	3	12	0	-
Both	Adult	47	44	94	3	6	3	6	0	-
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	0	-
	Combined	49	46	94	3	6	3	6	0	-

D.

Sex	Age Class	No Banded 1993	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	26	20	77	6	23	5	19	0	-
	Subadult	2	2	100	0	-	0	-	0	-
	Unknown	1	1	100	0	-	0	-	1	100
	Total	29	23	70	6	21	5	17	1	3
Female	Adult	23	20	87	3	13	2	9	0	-
	Subadult	2	2	100	0	-	1	50	1	50
	Unknown	1	1	100	0	-	1	100	1	100
	Total	26	23	88	3	12	4	15	2	8
Both	Adult	49	40	82	9	18	7	14	0	-
	Subadult	4	4	100	0	-	1	25	1	25
	Unknown	2	2	100	0	-	1	50	2	100
	Total	55	46	84	9	16	9	16	3	5

E.

Sex	Age Class	No Banded 1994	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	20	17	85	3	15	3	15	0	-
	Subadult	9	8	89	1	11	0	-	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	29	25	86	4	14	3	10	0	-
Female	Adult	27	23	85	4	15	3	11	0	-
	Subadult	3	2	67	1	33	0	-	0	-
	Unknown	3	3	100	0	-	0	-	0	-
	Total	33	28	85	5	15	3	9	0	-
Both	Adult	47	40	85	7	15	6	13	0	-
	Subadult	12	10	83	2	17	0	-	0	-
	Unknown	3	3	100	0	-	0	-	0	-
	Combined	62	53	85	9	15	6	10	0	-

F.

Sex	Age Class	No Banded 1995	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	26	20	77	6	23	5	19	1	4
	Subadult	5	3	60	2	40	1	20	2	40
	Unknown	0	-	-	-	-	-	-	-	-
	Total	31	23	74	8	26	6	19	3	10
Female	Adult	33	27	82	6	18	1	3	1	3
	Subadult	2	1	50	1	50	0	-	0	-
	Unknown	0	-	-	-	-	-	-	-	-
	Total	35	28	80	7	20	1	3	1	3
Both	Adult	59	47	80	12	20	6	10	2	3
	Subadult	7	4	57	3	43	1	14	2	29
	Unknown	0	-	-	-	-	-	-	-	-
	Combined	66	51	77	15	23	7	11	4	6

G.

Sex	Age Class	No Banded 1996	RELOCATED N	RELOCATED %	MISSING N	MISSING %	REPLACED N	REPLACED %	MOVED N	MOVED %
Male	Adult	24	20	83	4	17	4	17	1	4
	Subadult	2	2	100	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	26	22	85	4	15	4	15	1	4
Female	Adult	29	26	90	3	10	3	10	1	3
	Subadult	1	1	100	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Total	30	27	90	3	10	3	10	1	3
Both	Adult	53	46	87	7	13	7	13	2	4
	Subadult	3	3	100	0	-	0	-	0	-
	Unknown	0	0	-	0	-	0	-	0	-
	Combined	56	49	88	7	13	7	13	2	4

TABLE 7a. Proportion of California spotted owl pairs nesting on the SNF.

YEAR	NESTING CHECKED N	PAIRS NESTING N	PROPORTION NESTING Percent
1990	8	5	0.63
1991	9	6	0.67
1992	30	27	0.90
1993	33	19	0.58
1994	33	19	0.58
1995	23	6	0.26
1996	25	6	0.24
1997	25	9	0.34

TABLE 7b. Proportion of California spotted owl pairs nesting on the SNP.

YEAR	NESTING CHECKED N	PAIRS NESTING N	PROPORTION NESTING Percent
1990	5	4	0.80
1991	11	2	0.18
1992	27	24	0.89
1993	25	15	0.60
1994	27	16	0.59
1995	31	5	0.16
1996	25	2	0.08
1997	26	6	0.23

TABLE 7c. Proportion of California spotted owl pairs nesting on the NS.

YEAR	NESTING CHECKED N	PAIRS NESTING N	PROPORTION NESTING Percent
1994	11	6	0.55
1995	9	1	0.11
1996	11	1	0.09
1997	10	2	0.20

TABLE 8a. Proportion of pairs of California spotted owls checked for reproduction by 15 July which fledged young on the SNF.

YEAR	Pairs Checked N	Pairs Fledging Young N	Proportion Fledging Young
1990	18	13	0.72
1991	13	5	0.38
1992	30	26	0.87
1993	33	14	0.42
1994	33	14	0.42
1995	26	1	0.04
1996	25	3	0.12
1997	25	6	0.24

TABLE 8b. Proportion of pairs of California spotted owls checked for reproduction by 15 July which fledged young on the SNP.

YEAR	Pairs Checked N	Pairs Fledging Young N	Proportion Fledging Young
1990	8	7	0.88
1991	12	1	0.08
1992	27	23	0.85
1993	25	11	0.44
1994	29	14	0.48
1995	33	2	0.06
1996	27	2	0.07
1997	27	6	0.22

TABLE 8c. Proportion of pairs of California spotted owls checked for reproduction by 15 July which fledged young on the NS.

YEAR	Pairs Checked N	Pairs Fledging Young N	Proportion Fledging Young
1994	11	5	0.45
1995	14	1	0.07
1996	12	1	0.08
1997	10	2	0.20

TABLE 9a. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the SNF.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	18	22	1.22
1991	13	6	0.46
1992	30	52	1.73
1993	33	23	0.70
1994	33	20	0.61
1995	26	1	0.04
1996	25	4	0.16
1997	25	8	0.32

Table 9b. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the SNP.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	8	12	1.50
1991	12	1	0.08
1992	27	43	1.59
1993	25	15	0.60
1994	29	22	0.76
1995	33	3	0.09
1996	27	3	0.11
1997	27	11	0.41

TABLE 9c. Mean number of young fledged per pair of California spotted owls checked for reproduction by 15 July on the NS.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1994	11	9	0.82
1995	14	1	0.07
1996	12	2	0.17
1997	10	4	0.40

TABLE 10a. Mean number of young fledged per pair of California spotted owls that fledged young on the SNF.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	13	22	1.69
1991	5	6	1.20
1992	26	52	2.00
1993	14	23	1.64
1994	14	20	1.43
1995	1	1	1.00
1996	3	4	1.33
1997	6	8	1.33

TABLE 10b. Mean number of young fledged per pair of California spotted owls that fledged young on the SNP.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1990	7	12	1.71
1991	1	1	1.00
1992	23	43	1.87
1993	11	15	1.36
1994	14	22	1.57
1995	2	3	1.50
1996	2	3	1.50
1997	6	11	1.83

TABLE 10c. Mean number of young fledged per pair of California spotted owls that fledged young on the NS.

YEAR	Pairs Checked N	Young Found N	Young Per Pair Mean
1994	5	9	1.80
1995	1	1	1.00
1996	1	2	2.00
1997	2	4	2.00

Table 11. Estimation of demographic parameters and rate of population change for the Sierra National Forest Study Areas, combined Sierra Study Areas, and the Sequoia and Kings Canyon National Parks Study Area

SNF		Sierra Forest		SNP	
1987-1992		----		1988-1992	
S_o =	0.349 (Est.)			S_o =	0.349 (Est.)
S =	0.8377			S =	0.8732
b =	0.656			b =	0.4653
Lambda	1.02484			Lambda	1.01316
z =	0.56027			z =	0.29181
1987-1993		----		1988-1993	
S_o =	0.349 (Est.)			S_o =	0.349 (Est.)
S =	0.8433			S =	0.9072
b =	0.548			b =	0.4227
Lambda	1.00395			Lambda	1.03634
z =	0.11409			z =	1.09853
1987-1994		----		1988-1994	
S_o =	0.349 (Est.)			S_o =	0.349 (Est.)
S =	0.8349			S =	0.9037
b =	0.484			b =	0.413
Lambda	0.97896			Lambda	1.03006
z =	0.69547			z =	1.05136
1987-1995		1987-1995		1988-1995	
S_o =	0.349 (Est.)	S_o =	0.349 (Est.)	S_o =	0.349 (Est.)
S =	0.8295	S =	0.8338	S =	0.8631
b =	0.405	b =	0.3702	b =	0.3365
Lambda	**0.95258**	**Lambda**	**0.94744**	Lambda	0.96783
z =	**1.77871**	**z =**	**2.05052**	z =	1.19524
P =	**0.038**	**P =**	**0.02**	P =	0.11
1987-1996		1987-1996		1988-1996	
S_o =	0.349 (Est.)	S_o =	0.349 (Est.)	S_o =	0.349 (Est.)
S =	0.8174	S =	0.8257	S =	0.8575
b =	0.3616	b =	0.3226	b =	0.2940
Lambda	**0.92850**	**Lambda**	**0.92608**	**Lambda**	**0.95011**
z =	**2.91207**	**z =**	**3.24961**	**z =**	**2.10198**
P =	**0.0018**	**P =**	**0.0006**	**P =**	**0.018**
1987-1997		1987-1997		1988-1997	
S_o =	0.328 (Est.)	S_o =	0.328 (Est.)	S_o =	0.328 (Est.)
S =	0.8318	S =	0.8356	S =	0.8692
b =	0.3350	b =	0.3004	b =	0.2827
Lambda	**0.930**	**Lambda**	**0.9246**	**Lambda**	**0.9537**
z =	**3.099**	**z =**	**3.632**	**z =**	**2.237**
P =	**0.001**	**P =**	**0.0001**	**P =**	**0.013**